

## INSERTION OF ASTROBIOLOGY IN PHYSICS JOURNALS IN BRAZIL

L. Nunes Rosa<sup>1</sup> and B. L. do Nascimento Dias<sup>2</sup>

### RESUMEN

Este trabajo tiene como objetivo presentar, en resultados preliminares, si la Astrobiología ha sido mencionada en las principales revistas científicas que tienen como uno de los enfoques la Enseñanza de la Física, a nivel de Grado en Física en Brasil. Hasta este punto de la investigación, se investigaron 389 trabajos publicados en la *Revista Ciência&Educação (C&E)*, 845 en la *Revista Brasileira de Ensino de Física (RBEF)* y 353 en el *Caderno Brasileiro de Ensino de Física (CBEF)*. Los resultados preliminares de la investigación muestran que esta ciencia todavía ha sido poco insertada y debatida en esas revistas.

### ABSTRACT

This work is intended to present, in preliminary results, whether Astrobiology has been mentioned in leading scientific journals which have as one of the focuses the Teaching of Physics, at the level of Physics Degree in Brazil. Up to this point in the research, were investigated 389 works published in the *Revista Ciência&Educação (C&E)*, 845 in the *Revista Brasileira de Ensino de Física (RBEF)* and 353 in the *Caderno Brasileiro de Ensino de Física (CBEF)*. The preliminary research results show that this science has still been little inserted and debated in those journals.

*Key Words:* astronomy education — sociology of astronomy

### 1. INTRODUCTION

Some oldest questions in human history - *Where did we come from?*, *Where are we going to?* and *Are we alone?* - don't depend solely on the existence (or non-existence) of Astrobiology, but they rather have ancient origin, since those are curious questions pertinent to our species since the beginning of civilization (Galante et al. 2019). Salvador Nogueira Leite (2019, p. 12), a Brazilian scientific journalist, also highlights the questions that guide the direction of Astrobiology: *if Physics and Chemistry are common throughout the Universe, is it also Biology? May the emergence of life on Earth have been the result of an unlikely accident or biological activity, with all its rich complexity, that manifests whenever the conditions are favorable? What exactly are these conditions? How often are they answered? What different worlds can house them and what is the extent of their reach across the Universe?*

Astrobiology is an emerging science, because it is an area of research that has grown exponentially since the fifties, not only in Brazil but also worldwide (Galante et al. 2019). According to the Brazilian Society of Astrobiology (BSA, 2021) website, Astrobiology begins to be addressed directly in Brazil

with the publication of the book *Introdução à Astrobiologia*, in 1958, by the biologist Flávio Augusto Pereira. A little more than two decades later, in 1982, Dr. Jorge Alberto Quillfeldt, from the Department of Biophysics of the Federal University of Rio Grande do Sul (FURGS), was responsible for the university extension course focused on Astrobiology, promoted by the Astronomical Society of Rio Grande do Sul (ASRGS), later giving rise to one of the first undergraduate courses focused on Astrobiology in the country.

Since then, other factors are considered directly responsible for the strong expansion and development of Astrobiology in Brazil. The work *Telegramas para Marte: A busca científica de vida e inteligência extraterrestres*, produced in the master and doctoral programs in Exobiology (old term used to refer to issues that are currently relevant to Astrobiology) by the historian Eduardo Dorneles Barcelos, published in 2001, in which he presents the state of the art in this science in several countries during the 20th century; the I Brazilian Astrobiology Workshop (I BWA), in 2006; the registration of a research group database of researchers and students in the National Council for Scientific and Technological Development (NCSTD), under the name *Astrobio-Brasil*, considered the first step towards the formalization of the area in the country, also in 2006; the creation of the Astrobiology Laboratory - *AstroLab* - under the

<sup>1</sup>Instituto Federal de Educação, Ciência e Tecnologia do Rio de Janeiro - IFRJ, *campus Nilópolis* (lucas.nunes@hotmail.com).

<sup>2</sup>Museu de Astronomia e Ciências Afins - MAST, Rio de Janeiro (bruno.astrobio@gmail.com).

coordination of Dr. Eduardo Janot-Pacheco, from the Institute of Astronomy, Geophysics and Atmospheric Sciences of the São Paulo University (IAG-SPU), and which formally started its operations in 2011.

We can also consider the creation of the Astrobiology Research Center (ARC-Astrobio) - a research center dedicated to Astrobiology - in 2010; the creation of the Brazilian Astrobiology Network in 2013; the creation of the Brazilian Society of Astrobiology (BSA) in 2017 and the 1st Annual Meeting of the Brazilian Society of Astrobiology, in 2018.

Besides that, for Rothschild (2019, p. 5), senior scientist at the Ames Research Center – NASA, Astrobiology is a metadiscipline using all useful science, wherever it can be found. This area of research requires the interaction of scientists who would otherwise probably not meet, needing much less work to develop collaborative and highly complex research work (Galante et al. 2019). In this way, the development and progress of Astrobiology occur through the mutual cooperation of other sciences, such as Astronomy, Astrophysics, Biology, Chemistry, Geology and Physics (Cockell 2020).

## 2. PURPOSE AND METHODOLOGY

This work is intended to present, in preliminary (since other journals will still be mapped) results, whether Astrobiology has been mentioned in leading scientific journals which have as one of the focuses the Teaching of Physics, at the level of Physics Degree in Brazil.

Up to this point in the research, the following journals were mapped: *Revista Brasileira de Ensino de Física (RBEF)*, *Revista Ciência e Educação (C&E)* and *Caderno Brasileiro de Ensino de Física (CBEF)*. These journals were chosen because they have the best concepts (A1, A1 and A2, respectively) in the area of Physics Teaching, according to the latest evaluation of the Sucupira Platform, platform which is responsible for conceptualizing such journals. We investigated only papers which were published between January 1, 2015 and May 29, 2021.

## 3. RESULTS AND DISCUSSION

From a total of 389 works investigated in the *Revista Ciência e Educação (C&E)*, only one paper that mentioned Astrobiology was found.

The article *MOOC: uma alternativa contemporânea para o ensino de astronomia* (de Souza & Cyprinao 2016) is a work where the authors present the evolution of the concept of distance education, culminating in the Massive Open Online Course

(MOOC), considering this method a viable alternative to astronomy education, differentiating it from the traditional classroom methods and other distance learning methods, in its scope, structure and general characteristics. The work was based on bibliographic research and multiple case study, in which the main MOOC platform in the world was tested for the operational and educational resources offered to students. From this study, a model was proposed for astronomy education.

From a total of 845 works investigated in the *Revista Brasileira de Ensino de Física (RBEF)*, six papers that mentioned Astrobiology were found.

The paper *Integrando o ensino de astronomia e termodinâmica: explorando a zona habitável no diagrama de fases da água* (Farias & Barbosa 2017) is a work in which the authors present an approach to the teaching-learning of Thermodynamics using current topics of Astronomy. In this direction, they discuss the conditions that potentially allow the emergence of life as we know it and use the concepts related to the Habitable Zone (HZ) in an integrated way to the teaching of Thermodynamics, focusing on the phase diagrams. They also use the Stefan-Boltzmann's law and the concept of effective temperature in order to formalize, in an introductory manner, the Habitability Zone in our Solar System. In addition, they discuss the pressure and temperature conditions of the rocky planets of the Solar System, comparing them with the liquid water phase diagram, and also illustrate how research in Astrobiology may help to find potentially habitable planets by analyzing data from the literature with possible scenarios for the atmosphere of the exoplanet candidate Gliese 581g.

The article *Habitabilidade cósmica e a possibilidade de existência de vida em outros locais no universo* (Vieira et al. 2018) is a work where the authors address some aspects related to the concept of life as we know it and explores the relationship between the chemical evolution of the Universe and the production of the basic elements of prebiotic chemistry. They based themselves on the Standard Cosmological Model to describe the cosmological conditions that led to the emergence of these elements, showing evidence that the Universe, in its primordial stages, had elements capable of producing organic substances. They briefly discuss how chemistry in astrophysical environments leads to the formation of compounds that are part of the chain of reactions that lead to the formation of “bricks of life”. Finally, they hypothesized that the universe could have habitable zones from the first 30 million years and that the habitability condition has a close

relationship with its chemical evolution, even when it is taken into account the hypothesis of different universes.

Eudoxo's model presents itself as the first attempt to understand, with the observations and tools of mathematics of the time, the movements of the Sun, the Moon and the retrograde movements of the planets. The paper *Primeiro método matemático da cosmologia: as esferas concêntricas de eudoxo* (Velásquez-Toribio & Oliveira 2019) is a work in which the authors use the Aristotle's comments, the Simplicio's writings and approaches made by historians and mathematicians in the 19th-century to present the classical mathematical reconstruction of the concentric spheres model, that represents the first mathematical model of cosmology, which attempts to explain the movement of celestial bodies. In addition, they also use the rotation matrix method to illustrate the planetary movements resulting from the Eudoxo model and determine the parametric equation of the hippopede.

The article *Origens da vida no contexto cósmico: o primeiro MOOC em astronomia desenvolvido no Brasil* (de Souza & Cypriano 2020) is a work where the authors present the methodology used for the creation of the MOOC *Origens da vida no contexto cósmico*, the first astronomy initiative in Portuguese, inaugurated in 2016. It is shown that this MOOC was already accessed by more than 150,000 students, but it was identified that the completion rate of the course was around 9%, with predominance of students with higher education and male gender. On a scale of 0 to 5, the level of student satisfaction with the course was rated at 4.8. Besides that, the course already transcends the barrier of the virtual world and has been used as a learning aid tool in elementary and high schools.

Sciences such as Astronomy, Astrophysics, Physics and Modern and Contemporary Cosmology have as main goal to understand, through mathematical, computational and observational methods, the fundamental astrophysical processes related to the kinematic description, the dynamic, temporal and chemical evolution of different celestial objects - such as planets, stars, galaxies and galaxy clusters - and, lately, the formation, constitution and evolution of the Universe. The paper *Complexidade em Astronomia e Astrofísica* (Alves-Brito & Cortesi 2020) is a work in which the authors discuss the concept of complexity and phenomena considered quite complicated and intricate that have demanded new and

challenging theoretical and methodological approaches in Astronomy and Astrophysics, which are among some of the most fascinating basic sciences of the 21st century.

From a total of 353 works investigated in the *Caderno Brasileiro de Ensino de Física (CBEF)*, no work was found that mentioned Astrobiology.

#### 4. CONCLUSION

Although Astrobiology has been booming in recent decades, these preliminary research results show that this science has still been little inserted and debated in the main journals oriented to the Teaching of Physics, at the level of Physics Degree in Brazil.

It is important to emphasize that it is essential to bring current and developing issues in the scientific field closer to university students, so that they feel more motivated and interested in Science itself (Masetto 2006). However, the preliminary results don't seem favorable to students (and, therefore, to future Physics teachers) in order to become interested in Astrobiology, since this science has been little presented in those journals.

#### REFERENCES

- Alves-Brito, A. & Cortesi, A. 2020, *Revista Brasileira de Ensino de Física*. Vol. 43, sppl. 1
- Cockell, Charles S. 2020, *Astrobiology: Understanding Life in the Universe*. 2 ed. USA: John Wiley&Sons
- de Souza, R. & Cypriano, E. F. 2016, *Revista Ciência & Educação*. Vol. 22, n° 1, 65
- de Souza, R. & Cypriano, E. F. 2020, *Revista Brasileira de Ensino de Física*. Vol. 42
- Farias, M. L. L & Barbosa, M. A. A. 2017, *Revista Brasileira de Ensino de Física*. Vol. 39, n° 4
- Galante, D. et al. 2019, *Astrobiologia: uma ciência emergente* (Livraria da Física, São Paulo, ed. 1)
- Leite, S. N. 2019, Apresentação in: Galante, D. (Org.). *Astrobiologia: uma ciência emergente* (Livraria da Física, São Paulo, ed. 1, January 1, 2019).
- Masetto, M. T. 2006, In *Didática e Interdisciplinaridade*, I. Fazenda, ed. 1. (Papyrus, São Paulo)
- Rothchild, Lynn J. 2019, Prefácio in: GALANTE, Douglas (Org.). *Astrobiologia: uma ciência emergente*. 1. ed. São Paulo: Livraria da Física
- Sociedade Brasileira de Astrobiologia (SBA), 2021. *Sociedade Brasileira de Astrobiologia*. Available in: <https://www.sbastro.bio.org/>. Access in: September 8, 2021.
- Velásquez-Toribio, A. M. & Oliveira, M. V. 2019, *Revista Brasileira de Ensino de Física*. Vol. 41, n° 2
- Vieira, F. et al. 2018, *Revista Brasileira de Ensino de Física*. Vol. 40, n° 4